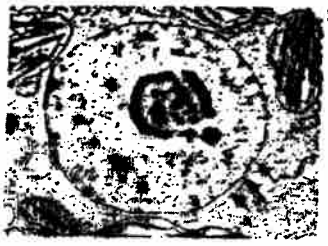
K1

The Structure of Membranes

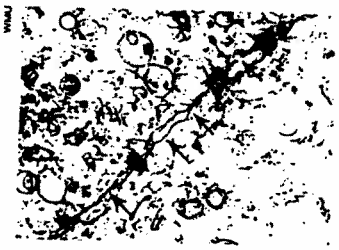
All cells have a cell membrane that forms the outer limit of the cell. Bacteria, fungi, and plant cells have a cell wall outside this, but it is quite distinct and lies outside the cell membrane. Cell membranes are also found inside eukaryote cells, making up the membranous **organelles** (e.g. mitochondria, chloroplasts, endoplasmic reticulum, vesicles, vacuoles, and golgi apparatus). These membranes control the entry and exit of substances from the organelle. Membranes also fulfill a role in recognition and communication between cells. Some membranes are involved in the transport of materials while others perform a storage function. Above all, the cell's plasma membrane is the edge of life; separating the cell from its non-living surroundings.



The nuclear membrane that surrounds the nucleus helps to control the passage of genetic information to the cytoplasm. It may also serve to protect the DNA.

Mitochondria have an outer membrane that controls the entry and exit of materials involved in aerobic respiration. Inner membranes provide attachment sites for enzyme activity.

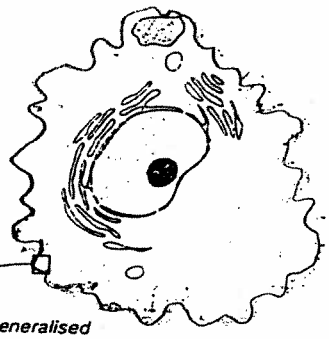
The golgi apparatus comprises stacks of membrane-bound sacs (*s*). It is involved in packaging materials for transport or export from the cell as secretory vesicles (*v*).



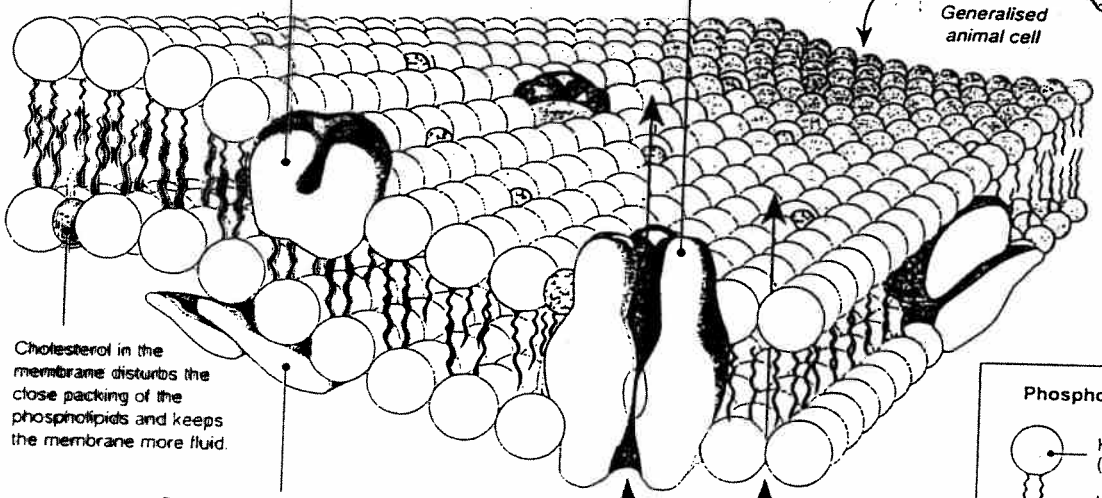
The entire cell is surrounded by a **plasma membrane** which controls the movement of most substances into and out of the cell. This photo shows 2 neighbouring cells (arrows).

The Fluid Mosaic Model for Membrane Structure

The currently accepted model for the structure of membranes is called the fluid mosaic model. In this model there is a double layer of lipids (fats) which are arranged with their 'tails' facing inwards. The double layer of lipids is thought to be quite fluid, with proteins 'floating' in this layer. The mobile proteins are thought to have a number of functions, including a role in active transport.



Generalised animal cell



Some proteins play an important role in immune responses. They identify the cell as belonging to the body and not to that of some invading pathogen.

Some proteins completely penetrate the lipid layer. These proteins may control the entry and removal of specific molecules from the cell.

Double layer of phospholipids (called the lipid bilayer)

Cholesterol in the membrane disturbs the close packing of the phospholipids and keeps the membrane more fluid.

Some proteins are stuck to the surface of the membrane

Some substances, particularly carbohydrates and ions, are transported across the membrane via the proteins

Some substances, including water, are transported directly through the lipid layer

Phospholipid Molecule

Hydrophilic end (water attracting)

Hydrophobic end (water repelling)

in a bilayer.

1. Briefly describe what membranes are made of: phospholipids, proteins (integral & peripheral), cholesterol, carbohydrate attachments.

2. Name two general functions that membranes have in cells: control of entry/exit of substances; protection.

3. (a) Name a cellular organelle that possesses a membrane: mitochondria, chloroplast, nucleus, ER

1. Define the term **diffusion:** The net flow of molecules/atoms/ions (particles) from high concentration to low concentration.

2. Explain what is meant by a **semi-permeable membrane:** a membrane that "allows" some substances to pass through, but not others.

3. Describe how the following factors will affect the rate of diffusion of a substance:

   (a) Concentration of molecules: ↑ [molecule] difference across membrane, ↑ rate of diffusion.

   (b) Size of the molecules: ↓ size of molecules, ↑ diffusion rate.

   (c) Density of the environment the substance is diffusing through (ie. solid/liquid/gas): ↓ density of environment, ↑ diffusion rate

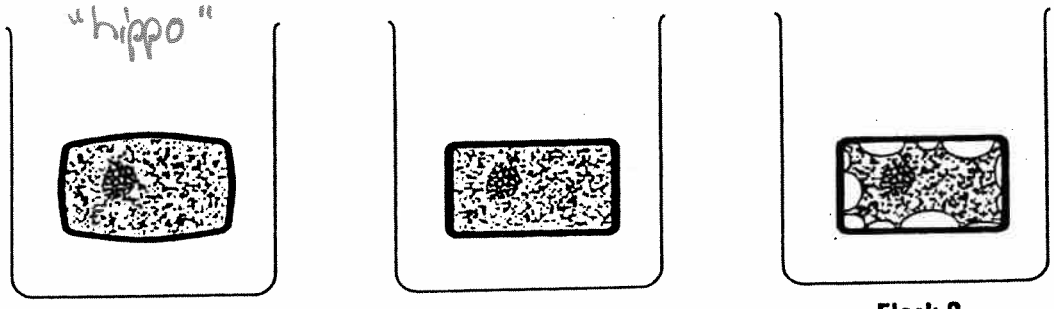
   (d) Temperature: ↑ Temp, ↑ diffusion rate.

4. Name two biological processes where diffusion plays an important role:

   (a) Respiration: gas exchange ex.) @ your alveoli

   (b) Digestion: absorption of nutrients.

5. In each of the flasks below, a plant cell was placed in a salt solution of different concentration. For each of the flasks (labelled A-C) below, describe the concentration (hypertonic, isotonic, hypotonic) of the salt solution surrounding the cell (given the cell condition shown) and the effect it has had on the cell (normal, plasmolysed or turgid):



Flask A | **Flask B** | **Flask C**

Saltiness of the water in the flask: hypotonic | isotonic | hypertonic

Cell condition: turgid (Animal cells would burst: lysis) | (normal) | plasmolysed. (Animal cells would shrivel: crenation)

6. Explain the purpose of the plant cell wall in limiting osmotic flow into the cell: cell wall is rigid and does not "give way". Turgor pressure is created.

7. (a) Describe what would happen if a red blood cell was placed into pure water (hypotonic environment): water enters the cell, cell expands and bursts (lysis)

   (b) Describe what would happen if a red blood cell was placed into a strong salt solution (hypertonic environment): water leaves the cell, cell shrivels (crenation)

A 2

Active and Passive Transport

Cells have a need to move materials both into and out of the cell. Raw materials and other molecules necessary for metabolism must be accumulated from outside the cell. Some of these substances are scarce outside of the cell and some effort is required to accumulate them. Waste products and molecules for use in other parts of the body must be 'exported' out of the cell. Materials can move into and out of the cell without any effort on the part of the cell. They move by a process called diffusion, which is classed as a **passive transport** process since no energy is required to make happen. Other processes that move substances may involve the use of energy, and are classed as **active transport**.

Passive Transport

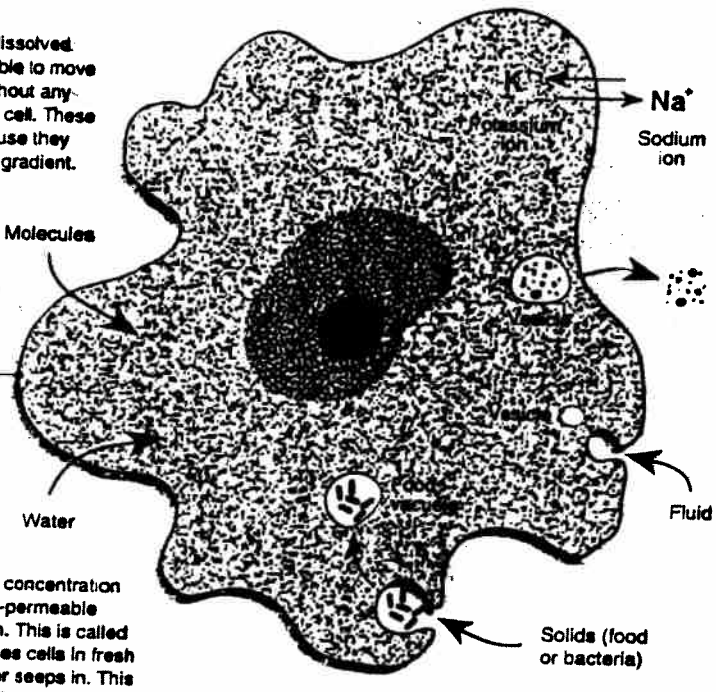
Diffusion

Molecules of liquids, dissolved solids and gases are able to move into or out of a cell without any effort on the part of the cell. These molecules move because they follow a concentration gradient.

Osmosis

Water can also follow a concentration gradient, across a semi-permeable membrane, by diffusion. This is called osmosis. Osmosis causes cells in fresh water to puff up as water seeps in. This water must be continually expelled.

Active Transport



Ion Pumps

Some cells need to control the amount of a certain ion inside the cell. Proteins in the cell membrane can actively accumulate specific ions on one side of the membrane.

Exocytosis

Vesicles budded off from the golgi bodies or endoplasmic reticulum can fuse with the cell membrane, expelling their contents. Common in cells that carry out secretion e.g. glands.

Pinocytosis

Ingestion of the fluid surrounding the cell. The cell membrane encloses some of the fluid and pinches off to form a vesicle.

Phagocytosis

Ingestion of solids from outside the cell. The cell membrane encloses a particle and buds off to form a food vacuole. Lysosomes will fuse with it to enable digestion of the contents.

1. Briefly describe the energy requirements of **passive** and **active** transport: passive: no ATP energy, only heat energy active: requires energy

2. Name a type of cell in the human body that requires an **ion pump** in order to function: nerve cell

3. (a) Describe what happens in the process of exocytosis: vesicles (from Golgi) fuse with cell membrane and expel contents

   (b) Name a secretory gland which has cells where **exocytosis** takes place: pancreas

4. (a) Pinocytosis and phagocytosis are two forms of **endocytosis**. Describe the general process of endocytosis: cell membrane buds inward to enclose fluid/solid and pinches off to form a vesicle.

   (b) Distinguish between pinocytosis and phagocytosis: pino: fluid (liquid/solution) phago: solids (ex. bacteria) → vesicle will usually fuse with lysosome

5. (a) Name a protozoan that would use phagocytosis for feeding: amoeba.

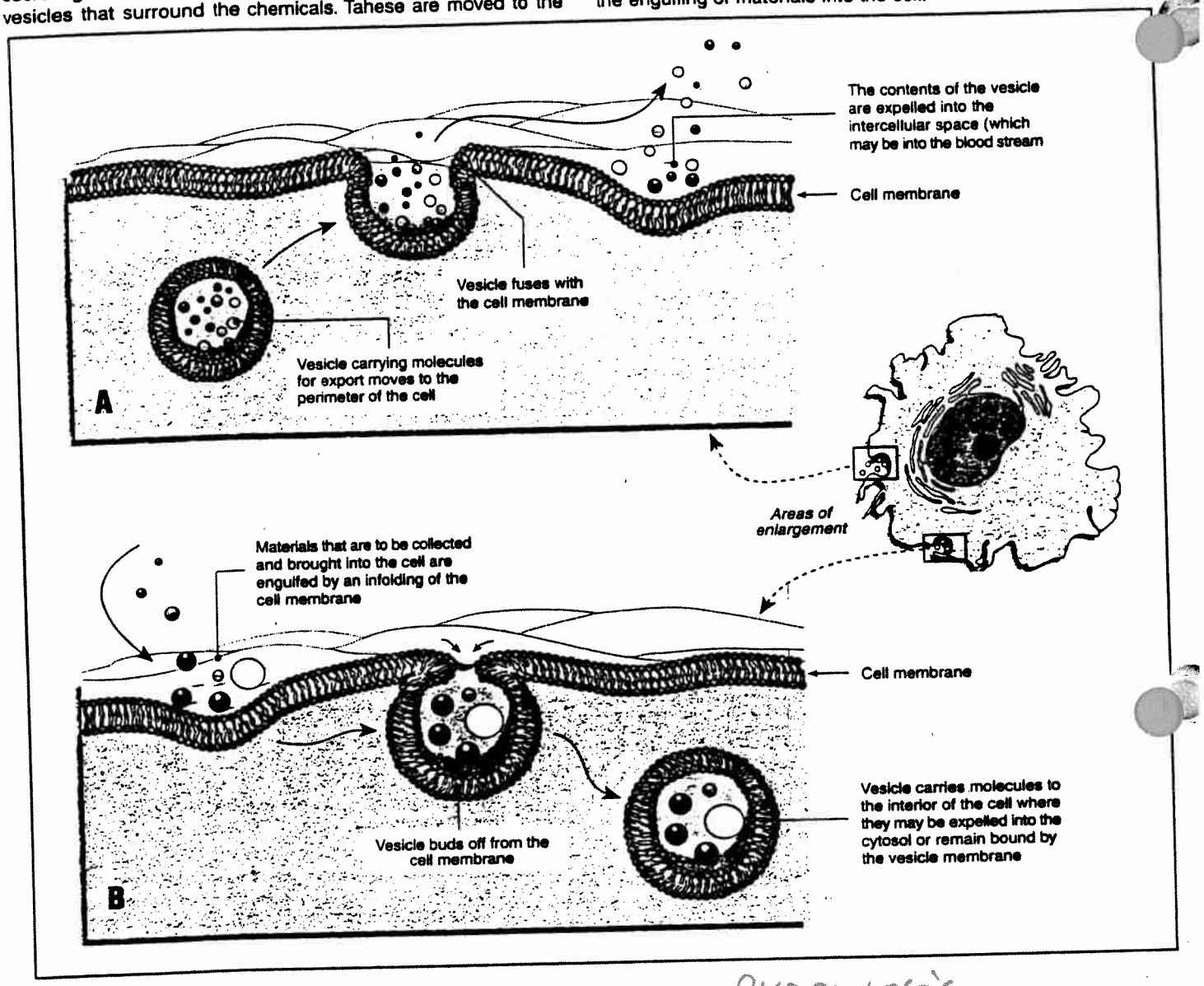
   (b) Name a type of human blood cell that uses phagocytosis in its functional role: white blood cell

6. Name two gases that move into or out of our bodies by diffusion: O_2, CO_2

RA 1

Exocytosis and Endocytosis

Cells have ways of moving packets of materials into and out of the cell. Cells that export chemicals (such as endocrine glands secreting hormones) can do so by creating membrane bound vesicles that surround the chemicals. Tahese are moved to the outer surface of the cell where they fuse with the cell membrane and empty their contents outside the cell – a process called **exocytosis**. The opposite process called **endocytosis** involves the engulfing of materials into the cell.



1. Name the cellular transport process illustrated in diagram **A** above: exocytosis

2. Explain the purpose of the process in **A** above: to export materials (such as enzymes, hormones, neurotransmitters) out of the cell.

3. Describe an example of when this process is used, and what typical cell type would be involved: enzyme secretion: pancreas cell to intestine.

4. Name the cellular transport process illustrated in diagram **B** above: endocytosis.

5. Explain the purpose of the process in **B** above: to import material (such as solution, bacteria) into the cell

6. Describe an example of when this process is used, and what typical cell type would be involved: white blood cell (immune system)